Hydrocarbon habitat of the Paleogene Nesvacilka Trough, Carpathian foreland basin, Czech Republic

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ABSTRACT

In the Czech part of the Carpathian foreland basin, oil and gas production started in the late 1930's. The hydrocarbon potential of this area is connected with the Paleogene sedimentary fill of the Nesvacilka Trough and its Mesozoic substratum. Ultimate recoverable reserves in established accumulation in Paleogene and Jurassic reservoirs amount to 8 x 10^6 bbls of oil and 14 BCF of gas. As stratigraphic prospects in Paleogene turbiditic and Middle Jurassic transgressive sands have a considerable upside potential, the Nesvacilka Trough is regarded as the most prospective hydrocarbon province of the Czech Republic.

At the transition from the Cretaceous to the Paleocene, the southeastern flank of the Bohemian Massif was uplifted and the complex and very large Nesvacilka-Vranovice system of palaeo-valleys deeply incised into its Mesozoic and Palaeozoic sedimentary cover. During Danian to Late Eocene times, these palaeo-valleys was progressively drowned by transgressing seas and filled in with up to 1500 m thick deeper water clastics of the Damborice Group, comprising the Paleocene Tesany and the latest Paleocene-Eocene Nesvacilka formation. The Tesany formation, consisting of sand-prone, deep-water proximal distributary channels cutting into levee/overbank shales, was deposited under rapidly rising sea-level conditions. Sandy conglomerates and coarse sands, deposited in fanlobes form the reservoirs of hydrocarbon accumulations. The Nesvacilka formation, consisting predominantly of hemi-pelagic shales, was deposited under upwards shallowing conditions and filled in the remaining palaeotopography; within it possible reservoir developments are restricted to slumps and barrier bars along the margins of the palaeo-valleys. Following an Oligocene regressive cycle, the area was incorporated during the Early Miocene into the Carpathian foreland basin. During the Late Miocene terminal phases of the Carpathian orogeny, the sedimentary fill of the Nesvacilka Trough was partly scooped out and overridden by the external flysch nappes.

Oil and gas accumulations are contained in stratigraphic and in combined stratigraphic and unconformity traps involving Middle Jurassic and Paleogene sands. Hydrocarbon charge is provided by autochthonous Late Jurassic source-rocks occurring beneath the adjacent Vienna Basin and by Paleogene shales which have reached maturity

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in the deeper parts of the Nesvacilka Trough, located beneath the external Carpathian flysch nappes.

INTRODUCTION

In the Czech part of the Carpathian foreland basin, the autochthonous sedimentary cover of the southeastern slope of the Bohemian Massif, has been explored for hydrocarbons since the 1920's when close to the surface a heavy oil accumulation was discovered. In the late 1950's, the Nesvacilka and Vranovice palaeo-valleys, which are cut deeply into the Mesozoic and Palaeozoic cover of the Bohemian Massif and are filled with Paleogene sediments, were first recognized (Fig. 1). During the early 1980's, the discovery of the Urice gas accumulation, having recoverable reserves of 5.3 BCF in Paleogene sands of the valley fill, triggered an intensified exploration program. However, of 8 wells drilled within the Nesvacilka Trough, only Karlin-1, located in its deepest parts, was successful and discovered a gas accumulation at the depth of 3900 m. Despite a considerable data base, consisting of wells and 2-D reflection-seismic lines, the distribution and prediction of reservoir sands and the definition of drillable prospects remained difficult. Since 1972, 400 km of 2D reflection-seismic lines were recorded and in 1991 70 km^2 of 3D seismic coverage were acquired. The drilling of 32 wells, including 15 wildcats, has yielded one oil and two gas accumulations having combined ultimate recoverable reserves of 8x 10^6 bbls of oil and 14 BCF of gas in Paleogene reservoirs of the trough fill and its Mesozoic substratum. The Paleogene system of palaeo-valleys, which extends over an area of some 1400 km^2, constitutes the most prospective hydrocarbon province of the Czech Republic (Jiricek, 1990; Benada et al., 1990; Ciprys et al., 1995).

GEOLOGICAL SETTING

Only the northernmost parts of Nesvacilka and Vranovice system of palaeo-valleys are located in the subsurface of the undeformed Carpathian foreland whereas its greater parts have been overridden by the most external Carpathian flysch nappes (Figs. 1 and 2). The sedimentary fill of these palaeo-valleys does not outcrop and ranges, according to well data, from Early Paleocene to Early Oligocene. The topographic relief of this fluvial palaeo-valley system, which is deeply incised into Palaeozoic and Mesozoic sediments, is of the order of 1500 m. As such, it developed in response to a major uplift of the southeastern flank of the Bohemian Massif, presumably during the latest Cretaceous.

The Nesvacilka and Vranovice system of palaeo-valleys extends over a distance of some 30 km from southeast of the city of Brno under the internal Carpathian Magura nappe where its definition is no longer possible due to geophysical resolution problems (Figs. 1 and 2). The morphology of the Nesvacilka and Vranovice system of palaeo-valleys, which must have presented a spectacular sight prior to its Paleogene flooding and infilling, is defined by reflection-seismic data, calibrated by wells, and in unexplored areas by means of gravity data. From the central, southeasterly trending Nesvacilka Trough, four lateral valleys branch off to the northeast and cut through several erosional terraces (Fig. 3). These lateral valleys, which are referred to as the Otnice, Milesovice, Koberice and Zarosice valleys (Fig. 9; Brzobohaty, 1993), played an important role during the infilling stage of the valley system in terms of providing lateral clastic influx into the axial Nesvacilka Trough. Only the Koberice valley did apparently become inactive at an early stage, presumably due to river beheading in its drainage area.

The Nesvacilka system of palaeo-valleys is superimposed on a down-faulted panel of the Bohemian Massif on which little deformed Devonian and Early Carboniferous strata are preserved; this downfaulted block is referred to as the Nesvacilka graben (Fig. 2). These downfaulted Palaeozoic strata, which overlay Cadomian basement forming part of the East Silesian block, attain a thickness of

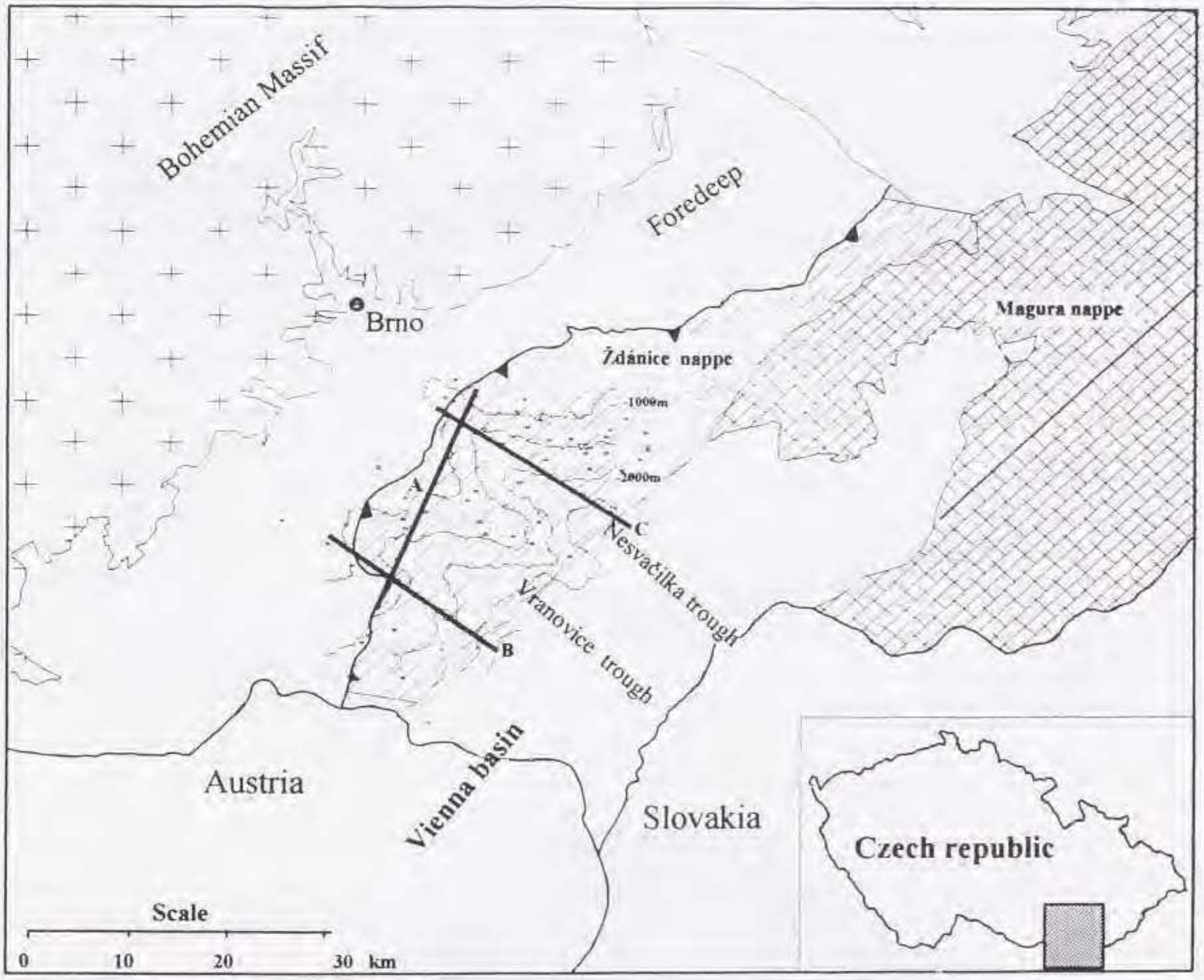

FIG.1. Schematic geological map of SE margin of Bohemian Massif showing depth contours for base of Nesvacilka and Vranovice troughs.and location of structural cross-sections given in Fig. 2.

2500 m. Middle Devonian continental sandstones rest on the crystalline basement and are overlain by Late Devonian limestones and dolomites (Fig. 3). These are followed by Early Carboniferous carbonates which pass upwards into shales and flysch-type sandstones and ultimately into a Namurian paralic sequence. A regional unconformity separates the Palaeozoic strata from a Mesozoic sequence which commences with Middle Jurassic sandstones and shales; these are unconformably covered by Callovian sandy dolomites. The entire Middle Jurassic sequence is some 300 m thick. Upper Jurassic carbonates and marls are the youngest Mesozoic strata occurring in the area and reach thicknesses of over 1000 m. At the transition from the Jurassic to the Cretaceous, the Bohemian Massif was uplifted in conjunction with major wrench deformations that must be related to rifting activity in the Arctic-North Atlantic domain and the North Sea (Ziegler, 1990). In the course of the Late Cretaceous, the flanks of the Bohemian massif were again transgressed. Based on regional palaeogeographic considerations, and as reworked Maastrichtian microfossils have been identified in the basal parts of the Nesvacilka palaeo-valley fill (Hamrsmid et al., 1990), it is assumed that also the southeastern flank of the Bohemian Massif was covered by at least a veneer of Late Cretaceous strata.

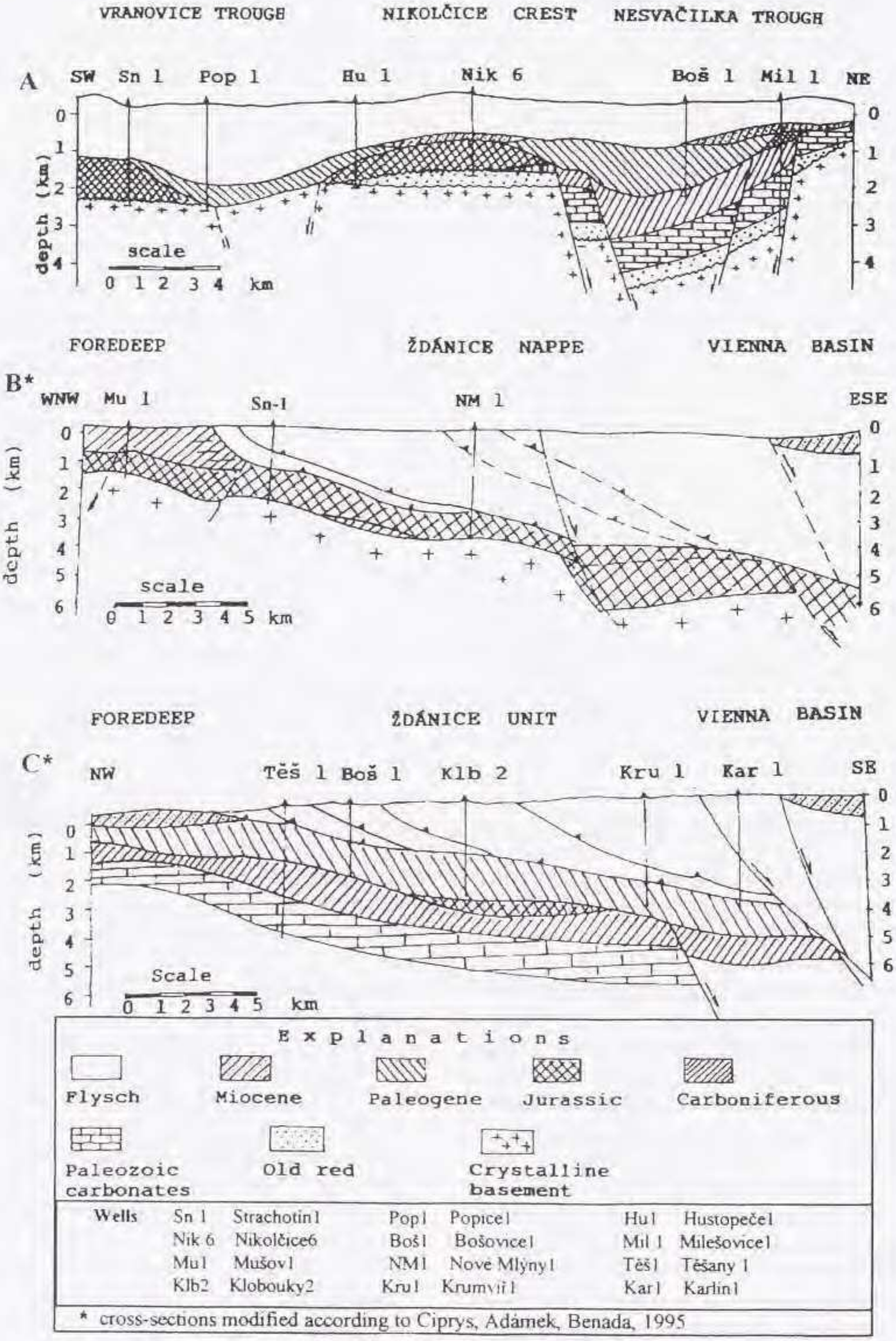

FIG. 2. Structural cross-sections through Nesvacilka and Vranovice troughs, for location see Fig. 1.

As indicated by the stratigraphic record preserved in the Central Bohemian Cretaceous Basin (Malkovsky, 1987) and in the substratum of the Austrian Molasse Basin (Nachtmann and Wagner, 1987; Wessely, 1987), uplift and internal deformation of the Bohemian Massif resumed in Late Turonian times, intensified during the Senonian and culminated during the Early Paleocene. This phase of intra-plate deformation, which resulted in the upthrusting of major basement blocks, was probably induced by compressional stresses which developed in response to collisional coupling between Eastern Alpine-Carpathian orogen and the European foreland (Ziegler, 1990).

Significant uplift of the southeastern parts of the Bohemian Massif, presumably during latest Cretaceous times, caused the development of a southeastwards directed drainage system which cut deeply into the Mesozoic and Palaeozoic strata and formed the Nesvacilka-Vranovice system of palaeo-valleys.

During the Early Paleocene, marine incursions, originating from Carpathian geosynclinal system, began to encroach on the rugged topography of the Nesvacilka-Vranovice canyons and by the Late Eocene the entire area was flooded. Marine Paleogene shales and sands, attaining thicknesses of up to 1500 m, are attributed to the Damborice Group, which, on the basis of a regional unconformity, can be subdivided into the Paleocene Tesany and the latest Paleocene to Eocene Nesvacilka formations (Fig. 4; Rehanek, 1993).

During the Early Paleocene first marine ingressions entered only the Nesvacilka Trough. However, during the Late Paleocene to Early Eocene, both the Nesvacilka and Vranovice troughs were flooded with only the high grounds of the canyon flanks still being exposed. The unconformity separating the Tesany and an the Nesvacilka formations, which cuts deeply into the Tesany formation, is attributed to a latest Paleocene temporary low stand in sea-level (Brzobohaty, 1993). By Late Eocene times, the entire area was inundat-

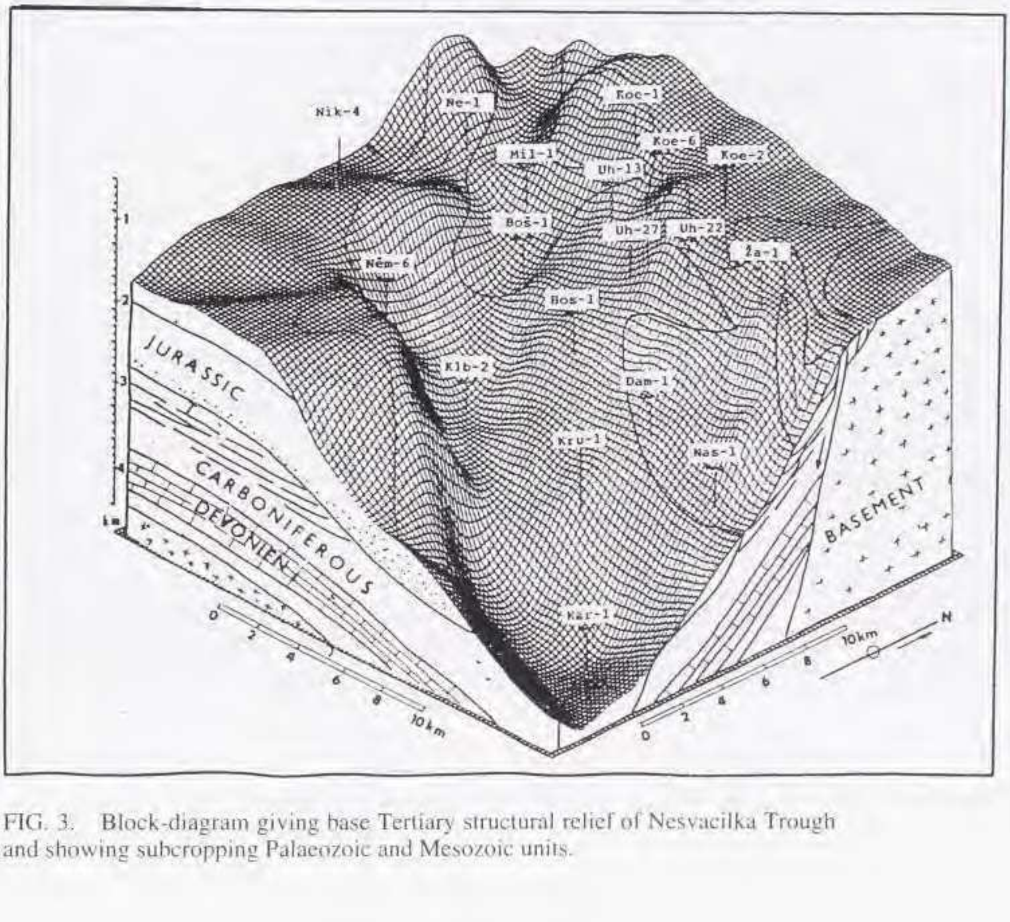

FIG. 3. Block-diagram giving base Tertiary structural relief of Nesvacilka Trough and showing subcropping Palaeozoic and Mesozoic units.

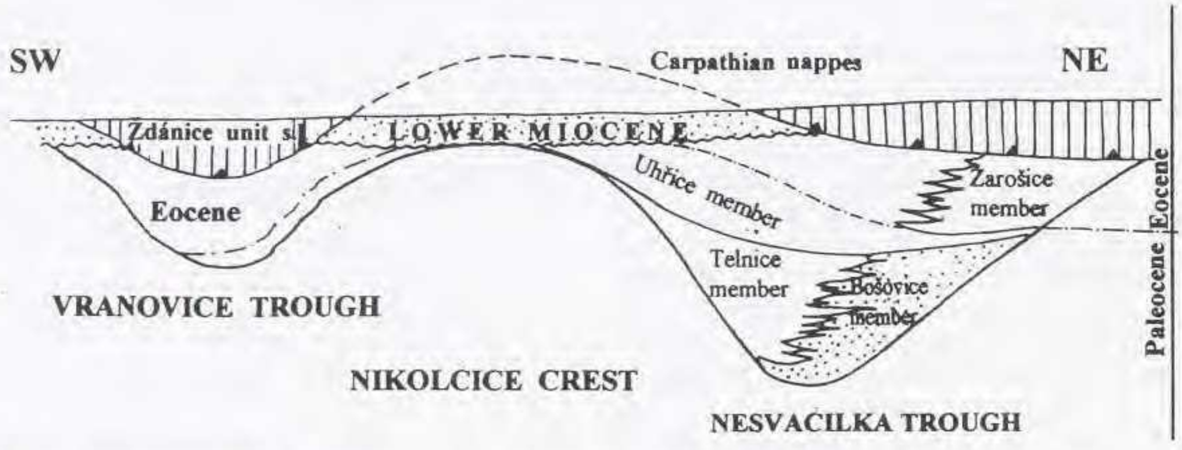

FIG. 4. Lithostratigraphy of Paleogene fill of Nesvacilka and Vranovice troughs.

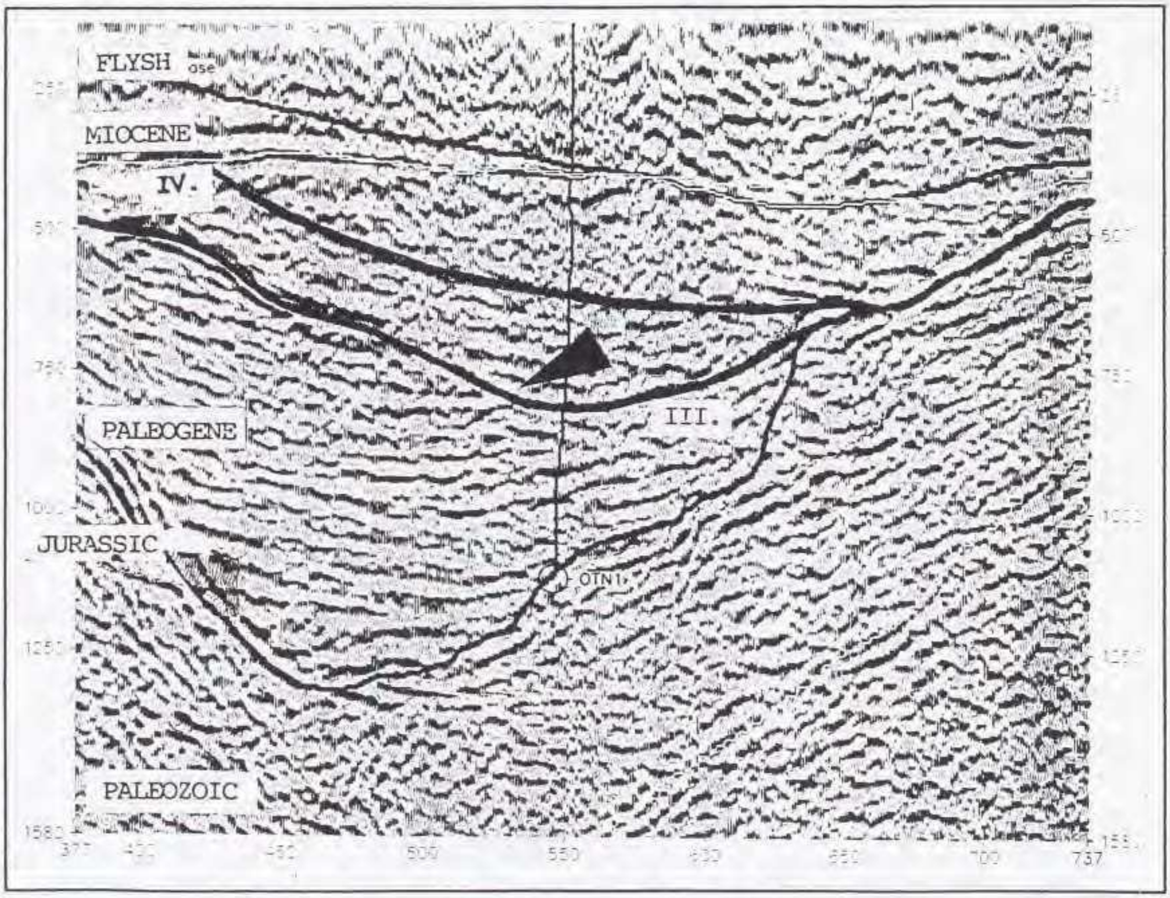

FIG. 5. Seismic Profile 250-86 showing examples of intra-Paleogene unconformities.

ed and much of the palaeo-valleys were infilled with clastics derived from the Bohemian Massif and with hemipelagic clays. At the transition from the Eocene to the Oligocene, a regional regression commenced that may be attributed to global climatic changes (Picha, 1979). However, autochthonous regressive Early Oligocene sediments occur only sporadically in some wells drilled near the northeastern margin of the Nesvacilka Trough. During the Early Miocene the area was incorporated into the Carpathian foreland basin. During the Late Miocene final phases of the North Carpathian orogeny, the upper part of the Paleogene sedimentary fill of the Nesvacilka and Vranovice trough was scooped out by thrust faults and overridden by the external flysch nappes (Fig. 2).

LITHOFACIES ANALYSIS OF PALEOGENE VALLEY FILL

On the basis of the available well data and seismo-stratigraphic criteria, the Paleogene sedimentary fill of the Nesvacilka and Vranovice troughs was subdivided into the Tesany and Nesvacilka formations and their internal lithofacies development analyzed in terms of depositional environments and the distribution of reservoir prone facies (Fig. 4; Rehanek, 1993). Based on core data, it was realized that both the Tesany and Nesvacilka formation were deposited under deeper water conditions. According to bentic foraminifera assemblages obtained from drill cores, the Tesany formation was deposited in water depth slightly greater than 200 m (Holzknecht and Krhovsky, 1987; Hamrsmid et al., 1990). The Nesvacilka formation was deposited under hemipelagic conditions. In our lithofacies analyses we followed the classification of Mutti et al. (1972).

Deposition of the **Tesany formation** was dominated by rapidly increasing water depths and high energy density current systems which came into evidence during the Early Paleocene but waned during the Late Paleocene. Waters were cold and characterized by considerable bottom currents. A turbiditic, sand-prone and a basinal shale facies, referred to as the Bosovice and Telnice members, respectively, are recognized (Fig. 4). The Bosovice member mainly consists of poorly sorted sandy conglomerates and coarse sands (lithofacies A and B); these are interpreted as fanlobe and meandering distributary channel deposits of the upper to middle parts of a submarine fan complex (Fig. 7). More locally, pebbly muds occur which are interpreted as slump deposits (lithofacies F). Channel fill deposits are characterized by polymict pebbles, brownish colour, amalgamated structures and frequent dark, plastically deformed clay chips with imprinted sand grains. The Telnice member consist of monotonous, dark silty claystones containing thin sand intercalations; these clays a interpreted as levee/overbank deposits (lithofacies D, E, F2). The presence of coaly fragments and a large amount of light micas is typical for the Telnice member.

The **Nesvacilka formation**, consisting mainly of hemipelagic clays, was deposited under gradually shallowing, warmer water conditions. A basinal and a marginal facies, referred to as the Uhrice and Zarosice members, respectively, are recognized (Fig. 4). The Uhrice member consists of monotonous, thinly bedded, variegated claystones containing silty layers (lithofacies G); coal fragments and particularly micas are conspicuously absent. Quiet bottom water conditions are indicated by traces of organic life on bedding planes. The Zarosice facies represents the shallow water, lateral equivalent of the Uhrice facies; it is only locally recognized on reflection-seismic data, such as along the mouth of the Zarosice valley, where it may include coastal barrier-bar sands. In much of the Nesvacilka and Vranovice troughs, the top of the Nesvacilka formation has been eroded prior to the transgression of the Early Miocene series.

Overall, the supply of sand to the Nesvacilka and Vranovice troughs decreased during the Late Paleocene and Eocene, probably as a consequence of progressive degradation of the palaeo-relief of the Bohemian Massif, a gradual northward advance of the shore-lines and progressive blocking of the feeder channels by increased hemipelagic clay supply.

Detailed analyses of 2D and 3D reflection-seismic data, applying seismo-stratigraphic interpretation methods, permit to unravel the internal architecture of the Paleogene fill of the Nesvacilka

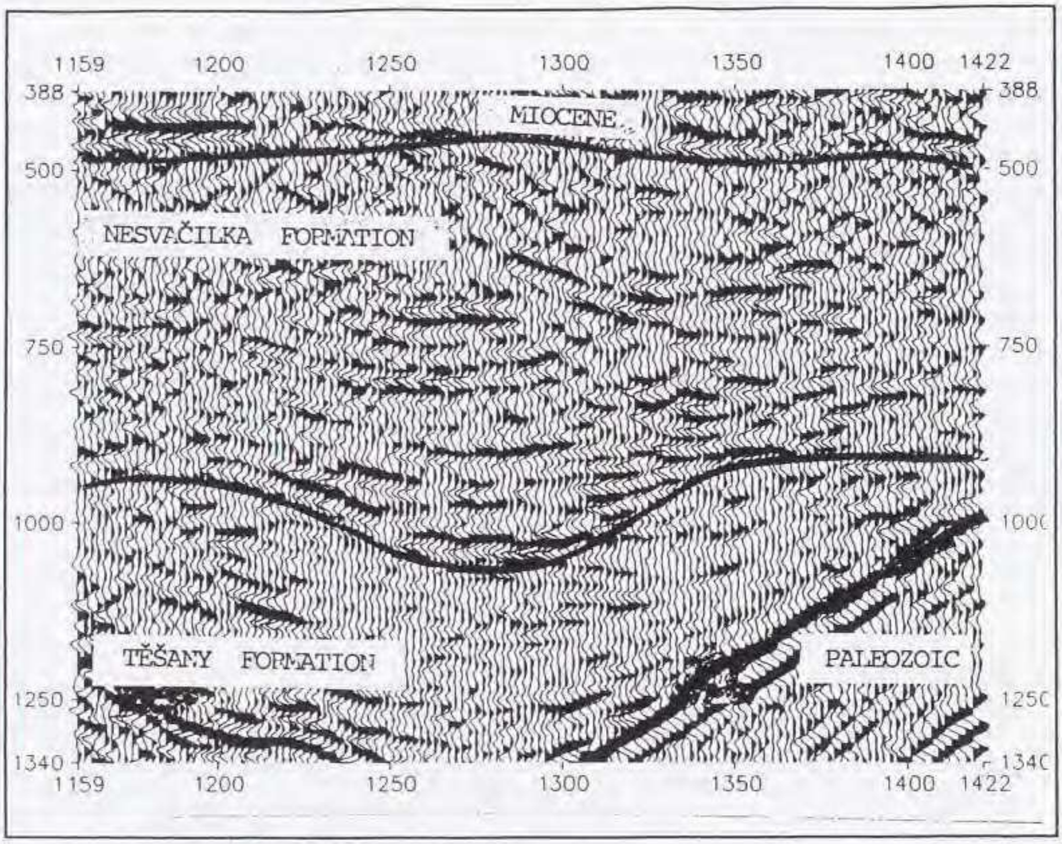

FIG. 6. Seismic Profile 308-87 showing an example of intra-Paleogene unconformity III

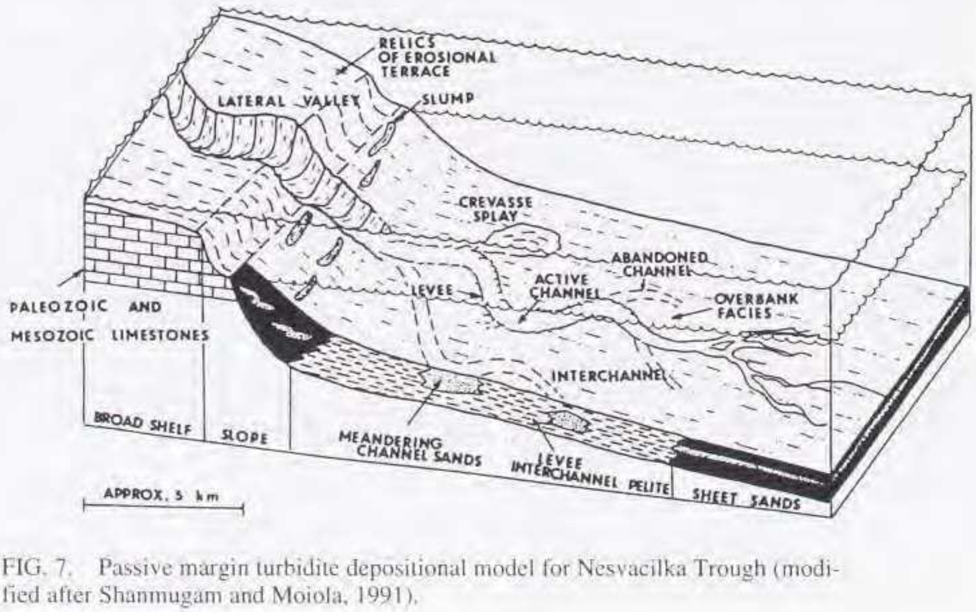

FIG. 7. Passive margin turbidite depositional model for Nesvacilka Trough (modified after Shanmugam and Moiola, 1991).

and Vranovice troughs which is characterized by a number of unconformities These are defined by reflection terminations, indicating down-cutting erosional truncation of the subcropping strata and onlap of the overlying strata; in some instances prograding and downlapping clinoforms can be observed. Examples of such unconformities are given in figs. 5 and 6. Cut-and-fill structures characterize the meandering channel deposits of the Tesany formation. Temporary low stands in sea-level and/or earthquake induced slope instabilities during Paleocene times gave rise to the development of at least two regionally correlative intra-Tesany unconformities (unconformity I and II). Unconformity I is the lowermost one within the Paleocene fill and is Danian in age; it has been recognized only in the Nesvacilka Trough. Unconformity II is of Thanetian age and is associated with a change in the Tesany depositional system and its basal onlap-relationship. The regionally recognized unconformity III marks a break in sedimentation between the Tesany and Nesvacilka formations. Unconformities IV and V occur within the Nesvacilka formation. Unconformity V coincides in the Vranovice Tough with the Middle-Late Eocene boundary but is not recognized in the Nesvacilka Through, probably due to deformation of the respective strata by thrusting during the final stage of the Carpathian orogeny.

A comparison of the age of the different unconformities recognized within the Paleogene fill of the Nesvacilka-Vranovice palaeo-valley sys-

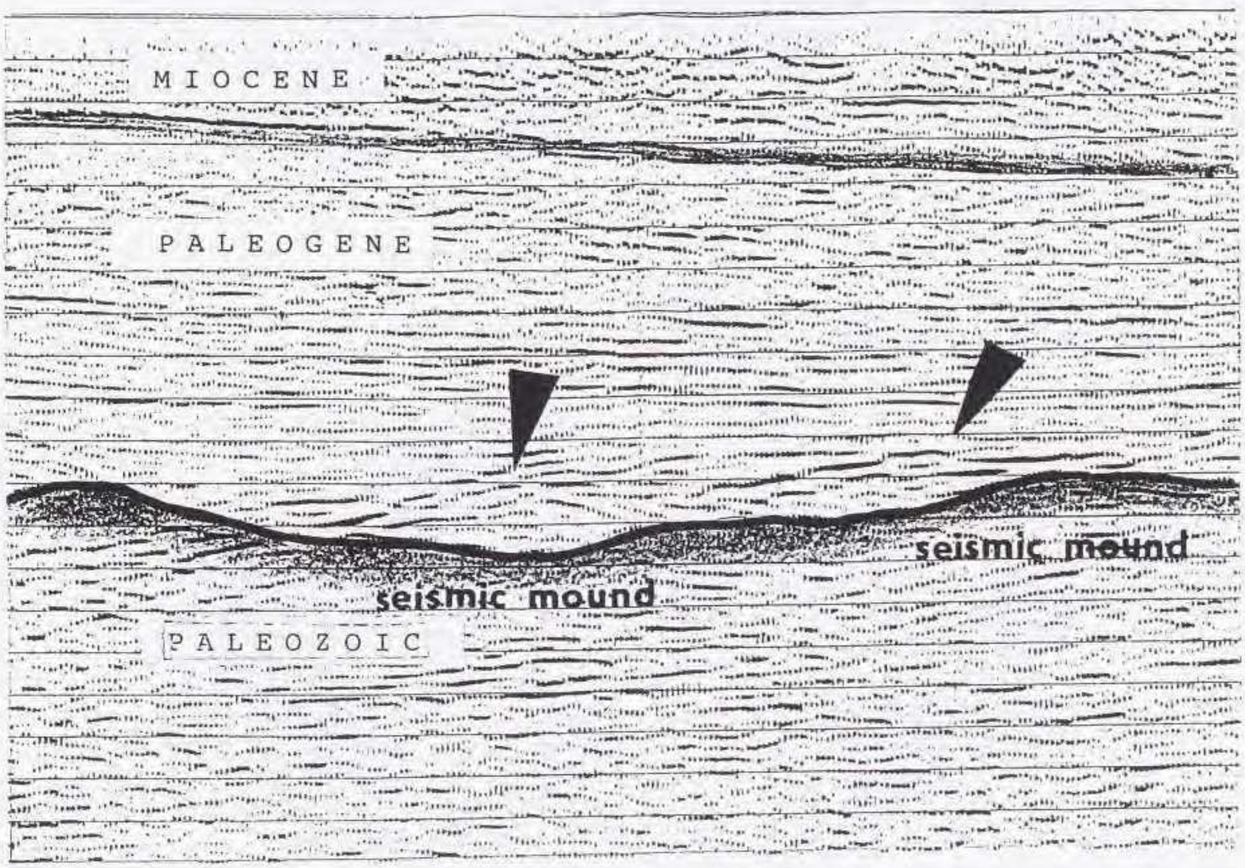

FIG. 8. Seismic Profile 377-87 showing an example of laterally shifting and accreting fan lobes in the Tesany Formation

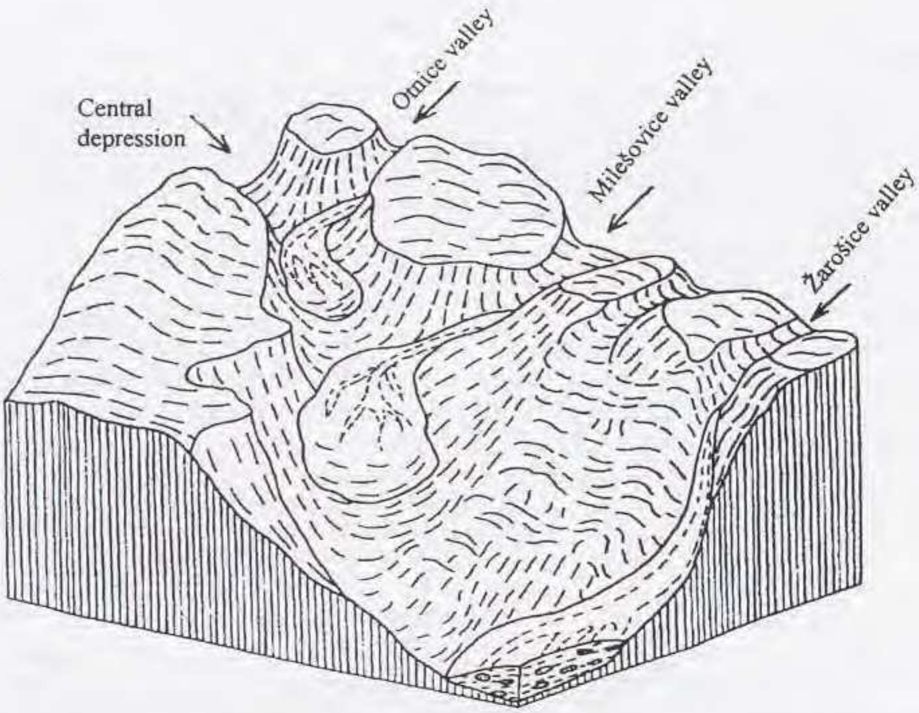

FIG. 9. Block-diagram showing palaeo-relief of central parts of Nesvacilka Trough during Paleocene times.

FIG. 10. Block-diagram showing palaeo-relief of central parts of Nesvacilka Trough during Eocene times

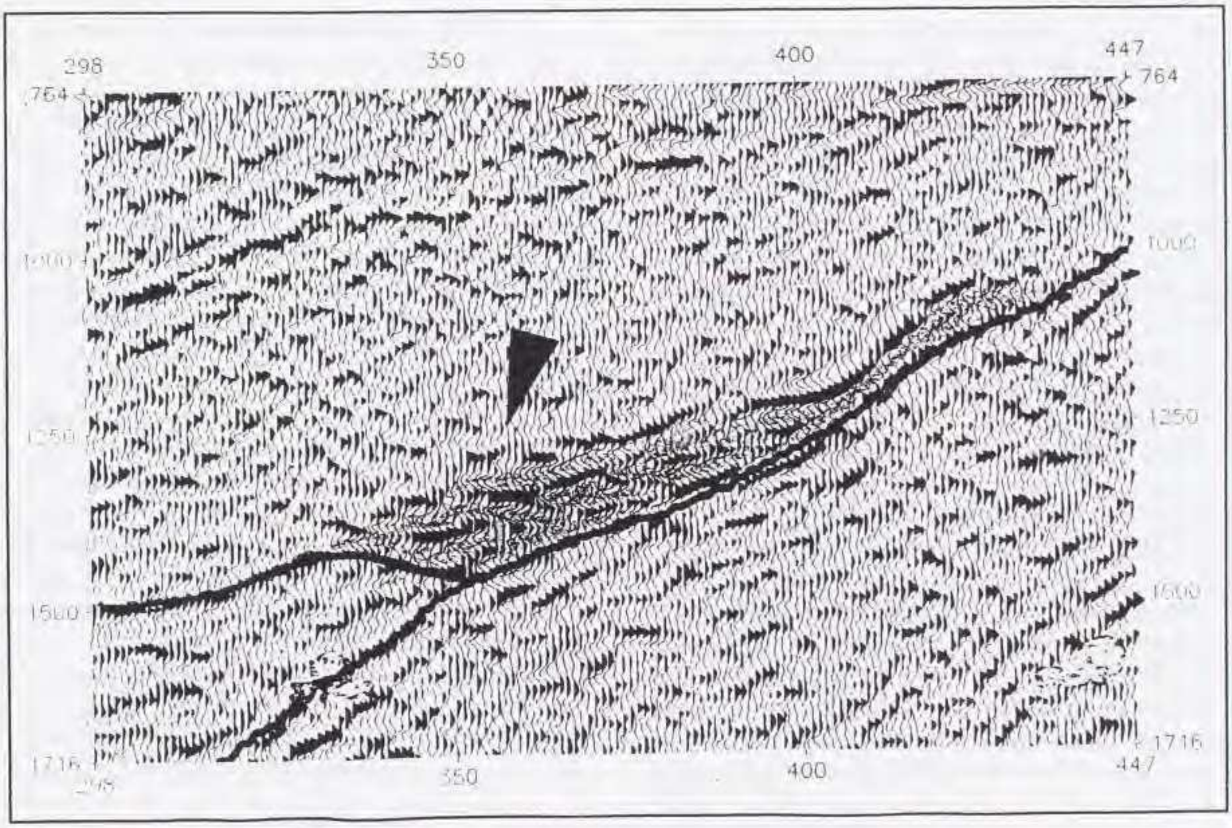

FIG. 11. Seismic Profile 243-80 showing an example of a large slump

tem and the sea-level curve of Haq et al. (1988) indicates that their development is not controlled by eustatic fluctuation in sea-level but is rather due to tectonically induced relative changes in sea-level, presumably reflecting crustal deformations caused by stresses related to the interaction of the Alpine-Carpathian orogen with the European foreland. In this respect it must be realized that the Tesany formation accumulated at a time when major compressional intra-plate deformations occurred in the Central European foreland of the Carpathians and Alps (Ziegler, 1989, 1990). However, at this stage we are unable to comment on possible dynamic processes which controlled the observed apparent sea-level changes and particularly the rapid Early Paleocene subsidence and flooding of the Nesvacilka-Vranovice system of palaeo-valleys.

DEPOSITIONAL PATTERNS AND RESERVOIR DEVELOPMENT

In our evaluation of the depositional pattern of the Paleogene fill of the Nesvacilka and Vranovice troughs, we applied the passive margin turbidite model of Shanmugam and Moiola (1991). During Paleogene times, the southeastern margin of the Bohemian Massif faced the deeper water Silesian Basin of the Carpathian orogenic system (Kovac et al., 1993). From this basin marine transgressions advanced northwards into the Nesvacilka and Vranovice troughs. However, in order to accommodate the peculiarities of the Nesvacilka-Vranovice trough depositional system, the Shanmugam and Moiola (1991) model had to be modified as shown in Fig. 7.

According to well data and detailed seismo-stratigraphic interpretations of reflection-seismic profiles, accumulation of turbiditic fan and fanlobe deposits in the Nesvacilka Trough commenced with its Early Paleocene rapid flooding and the establishment of deep water conditions. Similar deep-water fan deposits are described by Shanmugam et al (1988) from recent passive margins, such as the Gulf of Mexico. Recent fanlobes are characterized by sand-filled distributary channels and shaly-sandy levee/overbank deposits; upon compaction the sand filled channels form mounded features.

According to well data, the part of the Paleocene Tesany formation, which is bounded by unconformities I and II, is dominated by high energy sands and sandy conglomerates; these were deposited in deeper waters as fans and fanlobes. This sequence is referred to as the Bosovice member (Fig. 4). Particularly during this stage, the lateral valleys of the Nesvacilka Trough played a very important role in terms of clastic supply to the central trough (Fig. 9); the clastic load of rivers flowing through these valleys was derived from the elevated hinterland, as indicated by its polymict composition, as well as from the erosional terraces of the palaeo-valleys (Brzobohaty, 1993; Rehanek, 1993). Only along the lateral Otnice valley did turbiditic fans remained active till the latest Paleocene, whereas elsewhere coarse clastic supply to the Nesvacilka Trough had ceased earlier.

Seismic facies mapping permits to define fanlobes in the Tesany formation; Fig. 8 gives an example of a laterally shifting and accreting fanlobe which had entered the Nesvacilka Trough at the mouth of the Otnice valley. Such fanlobes appear on seismic data as mounded features and frequently display an internal two-directional downlap configuration. Similar fan-lobes had enter the Nesvacilka Trough at the mouths of the lateral Milesovice and Zarosice valleys and, after reaching the central trough, swung around and advance down its axis. According to seismic data, such laterally shifting channel deposits reach in the middle parts of fanlobes thicknesses of as much as 100-150 m where they consist of sandy conglomerates and coarse sands (lithofacies A and B according to Mutti et al., 1977). In the middle parts of the fanlobes, sandy channels alternate with fine grained levee deposits. Well logs from the middle parts of fanlobes show the characteristics of a cyclically upwards fining sequence.

Channel fills are considered as forming the most important hydrocarbon traps in the entire Paleogene fill of the Nesvacilka and Vranovice troughs. Their reservoirs are sealed by overbank/levee clays. Along the northeastern slope of the Nesvacilka Trough, the upper parts of coarse grained proximal fan deposits appear to have been cut off during temporary low stands in sea-level and are sealed by clays of the next following sequence. There are also cases of meandering channels which are cut-off ùp-dip by unconformities.

The upper parts of the Tesany formation, which are bounded by unconformities II and III, and the Nesvacilka formation consist mainly of monotonous hemipelagic clays. As such they reflect a significant decrease in clastic supply to the Nesvacilka Trough. As indicated by reflection-seismic data, these hemipelagic clays contain along the northeastern flank of the Nesvacilka Through in the interval between unconformity II and III a number of slumps or ponded lobes (Fig. 10; Brzobohaty, 1993). In Fig. 11 the reflection-seismic signature of such a slump feature is illustrated; its base appears to cut down into unconformity II and its internal configuration is rather chaotic, though its upper surface is marked by discontinuous, high amplitude reflectors which are indicative of a significant density-velocity contrast, and therefore also a lithological contrast. The lithological composition of such slump features is still unknown as they have not yet been tested by wells; although potentially prospective, such features carry a distinct reservoir risk (Shanmugam and Moiola, 1991).

Further potential reservoir developments may be associated with ancient shore-lines where barrier bar complexes are evident on 3D seismic data. Such shore-line sand bodies are, however, only rarely preserved as they have generally fallen victim to erosion during periods of low-stands in sea-level.

HYDROCARBON HABITAT

Within the Paleogene sedimentary fill of the Nesvacilka and Vranovice troughs two gas accumulations have been established, namely the Uhrice and Karlín fields (Fig. 12). These contain ultimately recoverable reserves 8.8 BCF gas. By now, both fields have been almost depleted. Gas production from the Uhrice field was 3.5 MMCF gas/day. This field in now being converted for underground gas storage. The reservoirs of the Uhrice and Karlín fields are formed by turbiditic sands of the Tesany formation. Traps are mainly of a stratigraphic nature and involve lateral sand pinch-outs and combined pinch-out and truncation geometries.

Apart from the Paleogene objectives, the Jurassic strata and particularly their lowermost parts, corresponding to the Middle Jurassic Gresten sandstone formation, are also prospective. These sandstones form the reservoir of the Damborice field, which contains ultimate recoverable reserves of 8×10^6 bbls of oil and is the largest oil field on the margin of the East-Bohemian Massif (Fig. 12). Prospects at Jurassic objective levels are formed by stratigraphic traps involving the onlap of Mesozoic strata against the regional top Palaeozoic unconformity.

According to geochemical analyses, including biomarkers, accumulations contained in Paleogene and Jurassic reservoirs were charged with hydrocarbons generated from Late Jurassic basinal marls and partly by Paleogene shales. According to rock-eval data, these source-rocks enter the oil window at a depth of about 4000 m (Ciprys et al., 1995).

Late Jurassic basinal shales, containing up to 2% of organic matter, occur in the autochthonous series beneath the Vienna Basin where they have partly entered the gas-window (Wessely, 1987; Ladwein, 1988). Hydrocarbons expelled by these shales apparently migrated laterally and updip into the Nesvacilka and Vranovice troughs. Similarly, hydrocarbons generated by Paleogene shales (up to 3.2% TOC) in the deeper, Carpathian sub-thrust parts of the Nesvacilka Trough, migrated laterally

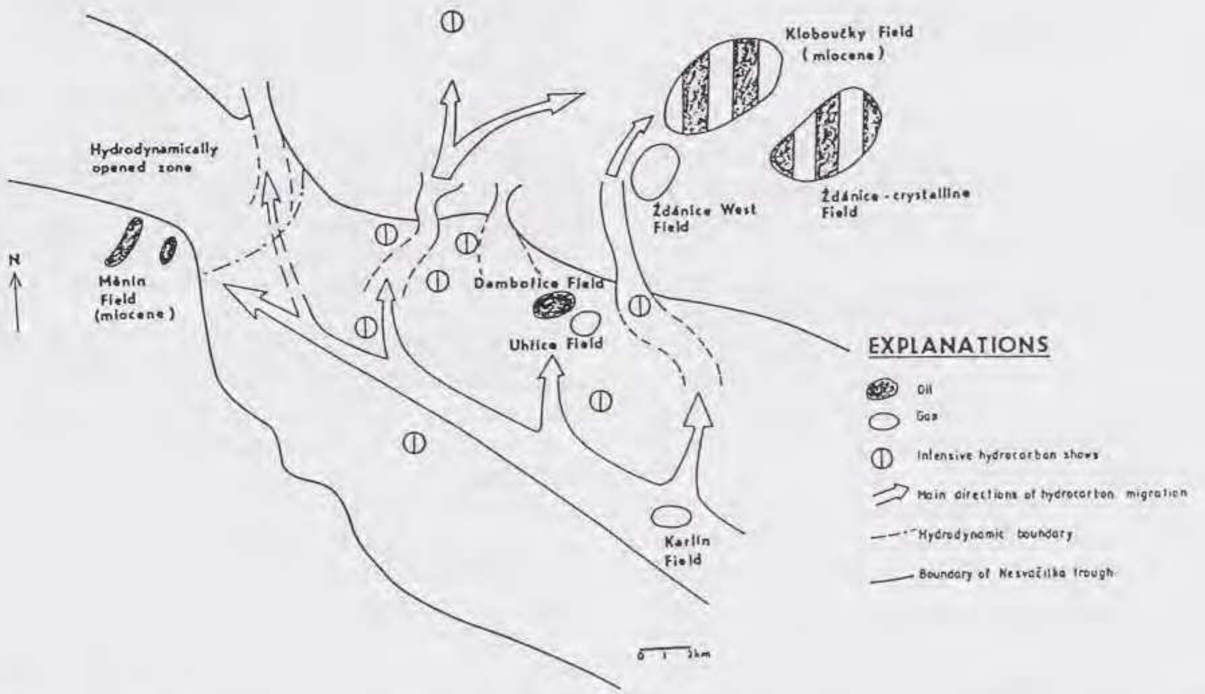

FIG. 12. Hydrocarbon accumulations of the Nesvacilka Trough and hydrocarbon migration paths.

and updip into Paleogene reservoirs. The main phase of hydrocarbon generation probably postdates the Late Miocene emplacement of the Carpathian nappes (Ciprys et al., 1995). As such, there is apparently no restriction on the hydrocarbon charge of remaining prospects recognized within the Nesvacilka and Vranovice troughs (Fig. 12).

Based on 2D and 3D seismic data, a Paleogene prospect inventory was established consisting of 12 potential stratigraphic traps involving turbiditic sands.The capacity of individual prospects was generally determined in volumes of oil and ranges from about 10 to 50 x 10^6 bbls. Correspondingly, the upside potential of as yet undrilled prospects is of the order of 275 x 10^6 bbls of oil. Nevertheless, we expect that some of these prospects are gas prone. Although an inventory of Jurassic prospects is not yet available and will be carried out after 3D seismic coverage has been enlarged, the Nesvacilka and Vranovice troughs must be regarded as the most prospective hydrocarbon province of the Czech Republic.

CONCLUSIONS

In the sub-surface of the Neogene North-Carpathian foreland basin the Paleogene Nesvacilka-Vranovice troughs correspond to a system of palaeo-valleys which were deeply incised into Palaeozoic and Mesozoic strata covering the Cadomian basement of the stable East Silesian block. These palaeo-valleys, which presumably developed in response to latest Cretaceous uplift of the southeastern flank of the Bohemian Massif, host an important hydrocarbon province which covers an area of about 1400 km^2.

Reservoirs and stratigraphic traps are provided by Early and Late Paleocene fanlobe-type turbidites, involving proximal channels filled with sandy conglomerates and coarse sandstones and more distal lenticular sand bodies related to meandering distributary channel-levee and overbank systems. During the latest Paleocene these turbidite systems became inactive in conjunction with progressive drowning out of the palaeo-relief. During the Eocene the entire valley system was infilled with hemipelagic clays containing along the tough flanks slump bodies and possible coastal barrier bar complexes. During the Early Miocene the area was incorporated into the Carpathian foreland basin. Late Miocene emplacement of the Carpathian flysch nappes was accompanied by thrust deformation of the upper parts of the Paleogene fill of the Nesvacilka and Vranovice troughs.

Within the sedimentary fill of these troughs, four regional unconformities are recognized on reflection seismic data; their development is related to tectonically induced relative changes in sea-level.

Geochemical analyses indicate that hydrocarbon charge is provided to the Nesvacilka and Vranovice troughs by autochthonous Late Jurassic marls and Paleogene shales which have reached maturity in the Vienna Basin.and beneath the Carpathian nappes, respectively Lateral and updip migration from these kitchens appears to have been very effective and is probably still going on.

Established accumulations, contained in Paleogene and Jurassic reservoirs, account for ultimately recoverable reserves of 8 x 10^6 bbls of oil and 14 BCF gas. Remaining prospects are stratigraphic traps, involving Paleocene turbiditic reservoirs, which are located at depths between 1000 and 3000 m and have an upside potential of the order of 275 x 10^6 bbls of oil. The prospectivity of Jurassic stratigraphic traps will be evaluated after additional 3D seismic coverage has been acquired. The Nesvacilka-Vranovice system of palaeo-valleys is the most prospective hydrocarbon province of the Czech Republic.

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